

Heredity, Environment, and Civilization*

Factors Controlling Human Behavior as Illustrated by the Natives of the Southwestern United States

By A. L. Kroeber, Professor of Anthropology, University of California

THE first of the several factors through which it is logically possible to explain the life and conduct and customs of the Indians of the Southwest is that of race or heredity, in other words, the inherited tendencies—physical and psychical, bodily and mental—which the people that carry these customs have or might have. The general attitude of anthropologists, at least those that are primarily concerned with modes of life, toward this factor of race or heredity as explanatory of the practices or conduct of peoples, is distinctly negative. At first sight it seems as if this element could not be left out of consideration. We know that peoples differ in inherited characteristics of body—complexion, features, hair, eye color, size, head-form, and the like. Theoretically, these bodily inherited peculiarities ought to be accompanied by mentally inherited traits; such as greater or less inclination to courage, energy, power of abstract thought, mechanical ingenuity, musical or esthetic proclivities, swift reactions, concentrating ability, gift of expression. These racial mental traits, again, theoretically should be expressed not only in the conduct but also in the customs and culture of each people. Races born to a greater activity of the mechanical faculties should possess more and higher inventions, those innately gifted in the direction of music should develop more melodious songs, and so on.

Yet ethnologists rather consistently refuse to fall back on such explanations. When it comes to using heredity as a cause in the interpretation of human institutions or national attainments, their reaction is literally an aloof one. I think I can speak for at least a majority of my colleagues on this point. What they do unanimously hold is that if there are such hereditary differences between human groups we have not yet been able to determine them. We must assume racial differences, and we know that there are also great differences in culture; but we cannot yet in any particular case prove the connection between them. We cannot yet say that heredity is the specific cause of this accomplishment, of this point of view, or of this mode of life. We cannot say that heredity is the determining factor to such and such degree of such and such customs.

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have discovered that long-headed peoples occur among some of the settled Pueblos and also among some of the nomadic tribes; and round-headed groups are also found among the settled and nomadic tribes. The Pueblo Taos and non-Pueblo Pima are both long-headed, the Pueblo Zuni and non-Pueblo Apache both broad-headed. Clearly, if the shape of the head has anything to do with the culture or mode of life of any of these peoples, the data that we possess fail to prove it. If there is any racial or hereditary reason for the differences in the mode of life, the reason is certainly a very much more subtle one that anyone has yet been able to establish.

So when we take up any other physical traits in regard to which we have information: results simply do not emerge. Dr. Hrdlicka found in a considerable number of cases, almost universally, in fact, that the pulse rate of Indians was about ten beats per minute less than that of white people—about sixty instead of seventy. While we do not know the specific cause of this phenomenon, it does seem to be hereditary. And to me it seems quite inconceivable that the physiological workings of two groups of people like Indians and Caucasians could differ so greatly without there being some reflex in their mental habits. Yet there are nomadic tribes such as the Apache that are renowned for their warlike habits, who lived as it were by fighting, and, on the other hand, there are the Zuni who are famous for their timidity and gentleness; and the pulse rates of such divergent tribes are the same. If slow pulse made for gentleness, as might be supposed, then we have the fact that the aggressive Apache has the identical pulse as the pacific Zuni. The conclusion that we must draw is that whatever the hereditary basis may be for the difference between ourselves and the Indian, it is an exceedingly intricate one, because we find all types of behavior both among the slow-pulsed Indians and among the rapid-pulsed Caucasians.

When we come to the second factor by which we might theoretically explain culture—the factor of physical environment or geography—our knowledge is not very much greater. You have probably all come across the type of Greek history which begins by giving a picture of the country—the dotted islands, blue skies, rocky headlands, and so forth—and in which the author then goes on to say something about how these gifts

where they know enough to manufacture the bow; or it has advanced so far that the bow is no longer of real utility, as among ourselves.

The determining factor then is not nature which gives or withholds the materials, but the general state of knowledge and technology and advancement of the group; in short, historical or cultural causes and not environmental causes.

The greater part of the Southwest is arid. Fish are distinctly scarce. The result is that most of the tribes get little opportunity to fish. Now we also find that most of these Southwestern Indians will not eat fish; in fact, think them poisonous. So one might say: Nature does not furnish fish in abundance; therefore the Indians got out of the habit of eating them; and finally came to believe them poisonous. At first blush this may seem a plausible reason. But in other parts of the world fish are prized as a delicacy just because they are scarce, and people feel about them very much as we do about oysters.

Then, too, fish might gradually become more abundant, or some of these tribes might move to a place where there always were plenty of fish, so that they would be living in an environment which differed from that in which their customs were formed; and yet we find that often even then they adhere to their old customs in contradiction to the new or altered environment.

We have just such a case in the Jews. It is often said that the Jew's prohibition against eating pork and oysters and lobsters originated in hygienic considerations; that these were climatically unsafe foods for him in Palestine. It is likely that this explanation is more picturesque than true. Ancient Palestine was not a country in which hogs could be raised with economic profit, and so they were not raised; and the Philistine and Phoenician kept the Jew from the coast where alone he might have obtained shellfish. Eating neither food, he acquired an aversion for them; and having the aversion, he said to himself that it was dangerous and irreligious to run counter to the aversion—just like our Pueblo Indian; and ended up by announcing that the Lord had issued the prohibition. Surely this is taking us a long way from the starting point of natural environment. This environment may indeed be said to have furnished the first occasion; but the determining

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I should like not to be misunderstood here. I do not deny that there is every probability that such inborn differences exist between many of the races. The point I am making is that we have as yet found no way of telling what is and what is not due to the heredity factor. The problem of science in general is to tie up one cause or factor with certain effects. The problem in the present case is to tie up definitely the specific race factor with specific phenomena of culture or group conduct, such as settled life, architecture in stone, religious symbolism, and the like; to be able to say so much of this symbolic expression is instinctive in the race and so much of it is the result of other influences. That is precisely what we cannot do; nor has anyone yet been able to find a method which he can honestly affirm will enable us to do it. This is a great pity. But I think you will agree that under the circumstances a clean scientific conscience does not allow us to do anything but to adhere to our negative attitude. When we do not know, the best thing is to say we do not know, in science as in business and in personal relations; when we are baffled, to admit we are baffled.

We anthropologists do feel that the greatest contribution we can make at present to an understanding of this factor of race is to work with the other factors with which we can deal specifically, and to push those other factors as far as we can in analyzing the phenomena of group conduct or culture. Meanwhile students in other branches of science—biology and psychology—can operate with this factor of heredity, which is more directly amenable to their techniques. Then when both they and we have made some progress, and the unknown quantities are proportionately reduced, we may be able to begin to connect the two sets of studies.

For instance, when we try to apply to the mode of life which we know these Indians of the Southwest to have had, such biological or racial facts as are at our command, we find that physical anthropologists, classifying peoples into long-headed and short-headed types, encounter both among the Southwestern Indians. They

«Extracts from an address delivered before the New York Academy of Science», at the American Museum of Natural History, April 22, 1918. This was the culminating lecture of a monthly series before the New York Academy of Sciences, all treating some phase of anthropological problems in the the southwestern United States. Republished from the *American Museum Journal*.

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It is the same with the theorist who derives the culture of the Central American Maya, the civilization of China and India, the origin of Mohammedanism, from alternating cycles of arid and humid climate. Such phantasies are best met by the recognition that whoever wishes to take the trouble can easily devise any number of conflicting but equally plausible theories.

It is of course obvious that a primitive tribe under the equator would never invent the ice box, and that the Eskimo will not keep their food and water in buckets of bamboo, although we can feel sure that if the Eskimo had had bamboo carried to him by the ocean currents, he would have been both glad and able to use it. Certain materials and opportunities are provided by nature and are made use of by every people. Other materials are not provided, and certain particular customs therefore cannot be developed as they might otherwise be. But all this is only negative. Two nations have ice and one invents and the other does not invent the ice chest; two of them have both bamboo and clay, and one draws water in bamboo joints and the other in pots. Obviously, natural environment does impose certain *limiting condition* on human life; but equally obviously, it does *not* *caute* inventions or institutions or progress of civilization.

We know a great many nations that have wood and sinews and flint and could make bows and arrows, but do not use them. They employ something else instead. Either their civilization has not advanced to the point

Palestine. It is likely that this explanation is more picturesque than true. Ancient Palestine was not a country in which hogs could be raised with economic profit, and so they were not raised; and the Philistine and Phoenician kept the Jew from the coast where alone he might have obtained shellfish. Eating neither food, he acquired an aversion for them; and having the aversion, he said to himself that it was dangerous and irreligious to run counter to the aversion—just like our Pueblo Indian; and ended up by announcing that the Lord had issued the prohibition. Surely this is taking us a long way from the starting point of natural environment. This environment may indeed be said to have furnished the first occasion; but the determining causes are of an entirely different kind—psychic or cultural, however we may want to call them. If any doubt remains, we need only look at the orthodox Jew of today in our country, where environment thrusts some of his tabooed foods at him as economically and hygienically satisfactory, and he still shudders at the thought of tasting them.

If this has happened among a civilized and intelligent people, the like must have occurred innumerable times among uncivilized tribes.

The invention of agriculture has often been associated with climatic factors. The first theory was that farming took its rise in the tropics, where agriculture came naturally. Only after people had acquired the habit and moved into other countries did they take their agriculture seriously on bringing it with them into these less favorable habitats. But it is just as easy to believe that the reverse happened. The attempt has actually been made to prove from the Southwest that it was the people of arid countries who invented agriculture, necessity driving them to it through shortage of natural supplies. McGee* has argued elaborately for this view on the basis of conditions among the Papago of Arizona and the Seri of Sonora.

Now it is plain that mere guessing is distinctly an unscientific procedure. In this particular case we can be reasonably sure that both guesses are wrong. Agriculture did not come to the Indians of the Southwest either because nature was favorable or because it was unfavorable. It came because, for reasons which we do not now need to examine, some people in southern Mexico or Guatemala or the northern part of South America turned agriculturists; and from them the art was gradually carried, through nation after nation, to our Southwestern tribes, and finally even to the Eastern Indians. The reasons for acceptance of this explanation are numerous. First, is the distribution of native agriculture. The farming region is about equally divided between the two continents, with its middle somewhere about Central America. Then there is the fact that in Central America and Mexico there was the

*W. J. McGee, The Beginning of Agriculture, *American Anthropologist*. Vol. VIII, 1895. pp. 350-375.

greatest concentration of population, which normally accompanies agriculture. Then, pottery has evidently spread out from the same center, and the two arts seem to go hand in hand. Other reasons might be adduced which are too lengthy to be pursued here: such as the indirect evidence of archaeological exploration. It is when these various facts are linked together that the full strength of the evidence is borne in upon us.

Now what caused the first tribe in or about Central America to practice agriculture, we do not know. But we have at least done something. We have accounted for the prevalence of agriculture in our aboriginal Southwest for several thousand years; and accounted for it wholly by a cultural or human explanation without reference to climate or geography or the topography of the country. In short, the environmental factor proves to be so remote or indirect or elusive that we cannot seriously operate with it.

The third set of factors with which we have to deal is what we may call the practices or behavior of people themselves taken in the mass—their type of culture or civilization. I do not mean necessarily high civilization, but type or kind of civilization irrespective of its level. We may in this sense speak as fairly of a Hottentot or Apache civilization as of Greek or French civilization.

We have in the Southwest a rather good example of how the phenomena of civilization usually arrange themselves when we look upon them geographically. In the center of our area we find four groups of Pueblo Indians—the Hopi, Zuni, Keres, and Tewa or Tano—who undoubtedly represent the *elite* of the native culture and, to a greater or less degree, of the aboriginal civilization of the United States. These four Pueblo tribes not only built towns of stone and lived almost wholly by agriculture, but they had worked out an exceedingly complex system of religion, with symbolic rituals, a kind of rude philosophy, and the like. When we leave these town-building people and come among the nomadic or semi-nomadic tribes, we first meet the Navaho, who, we find, have a good deal of the Pueblo culture. The great stone towns are lacking, but most of the noble religion persists. A little farther from the center, among the Apache and Pima, the religion has perceptibly diminished in elaborateness and fineness. As we radiate still more, the simplification of culture increases among the Mohave, most of whose cults are of a new and ruder kind. Still farther out, on the shores of the Pacific Ocean in southern California, among the Luiseno and Gabrielino, there are still a few distinctive but isolated Pueblo traits surviving. For instance, these Indians make ground paintings, symbolic representations or pictures of the universe, which are clearly based on the Pueblo type of altar. But for every such Pueblo-type

then spread afresh farther north from the minor Pueblo center, so undoubtedly many other elements of civilization have been diffused. Some day, for instance, we may be able to prove that the Southwestern clan system and type of religion have also in the main been shaped among some of the four Pueblo tribes or their ancestors; and that these in turn derived at least the rudiments or suggestions of these institutions from Mexico and Central America.

To designate Southwestern native culture as being outright Mexican would be slovenly, because it is plain that merely its basis or stimulus was derived from Mexico, and the great bulk of its content was reshaped on the spot. Just so the Mohave or Luiseno at the fringe of the Southwestern area undoubtedly got their cultural start from the Pueblos through the Pima or Apache, but are far from being mere dependents, because they have thoroughly worked over their cultural heritage from the Pueblos into something that is distinctively their own. They represent subcenters of development of civilization that stand in exactly the same relation to the Pueblo center as this stands to the Mexican supercenter; and the relation holds equally in space, in time, and in cause.

I believe that on the strength of this illustration I can claim that we anthropologists are working out some reconstruction of what happened. We are tracing back the history of man, not on the physiological or climatic side, but culturally; and showing, in some degree, how the civilization of the American Indian came to be. We have not gone so very far, it is true; but solid progress is not made by attempting to solve at one fell swoop all the problems that confront one.

There is one respect in which the culture of the Southwest is peculiar. It is constituted of two elements that are almost polar or opposites. We have the strictly agricultural Pueblos in their towns; and we have also the nomads that separate and surround them and show the same basic culture in a different form. The Navaho and Apache live scattered in small groups in temporary villages. Acoma and Zuni were inhabited as permanent cities when the Spaniard first marched into the land. The difference between these two types of Southwestern natives is striking: and the two dwell sandwiched in between each other. In no other part of North America does there appear to be any such extreme contrast in so small an area. Ordinarily we find such differences only among tribes that are far apart, and we must travel hundreds of miles before we encounter like changes. The differences are apparently greater than those in mediaeval Europe, and even there the case is not quite parallel, for the French noble and burgher and peasant were after all Frenchmen, whereas no such feeling of community of language or nationality unites

that the Pueblos found it exceedingly inconvenient to leave their stone dwellings every little while, and unprofitable or dangerous to live in temporary ones. They therefore subdued their feeling of dread as best they could and finally got rid of it. That is, I should give the economic cause precedence over the religious one. But it matters very little whether I am right or Dr. Goddard is right. We agree, and I think all anthropologists would agree, that there is a connection between the two factors involved in this matter.

This connection is in a sense cultural, in a sense psychological. It refers to an attitude of mind bearing on other attitudes of mind or habits. And that brings us to the last aspect under which we must consider human civilization: namely, as a product of interacting cultural factors each with its peculiar psychological coloring. The mental attitude that fears the dead is more than a mere psychological phenomenon. It is something that can be formulated in terms of culture and connected with cultural elements. The Navaho's emotion is to us no longer a pure or abstract emotion, but something that we can bring into positive causal relation with directly institutional factors such as architecture in stone or wood.

For instance, in temperament the Pueblo Indians are gentle. They are an exceedingly amiable people, showing some reserve, but not the stubborn reticence characteristic of so many of our Indians. They do not evince the manly, upstanding incisiveness of the Indians of the Plains, their directness in personal intercourse, the interesting play of individuality.⁴

Now I think it is very clear that one reason why the Pueblo is less incisive and personal in his mentality, is that his culture is much more pervaded by the idea of organization. To give a brief example chosen from the field of religion, there are about sixteen hundred Zuni, or a little more than three hundred adult males. Every one of these belongs to a communal religious society. At the head of this there are fourteen sets of four or five priests each, or one out of every six men. These are ranked and grouped, with certain divisions of function. In addition there is a head priest or sort of pope, one of a college of six cardinals, as they might be called, plus a speaker or sun-priest, a woman assistant, a grand dance manager, and two bow-priests or executive officers. The remaining Zuni are divided into six groups; each of which has its own kiva or ceremonial chamber, practically also a club. Each of these clubs has its manager and keeper of costumes. All this is only part of the scheme of organization of the one communal society. Beyond this are thirteen fraternal societies, each usually containing several grades or orders, and each with its head, deputy, speaker, and medicine keeper.

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We might represent these conditions graphically very much as Mr. N. C. Nelson* recently represented his findings in regard to the ancient culture of the Southwest. Without reference to the living Indians but on the basis of investigations of the remains of the past, he constructed a step pyramid which had for its apex this very region where the Pueblos are now. As he passed to each lower step, the archaeological remains were cruder and less notable, and each lower step was also so much nearer the periphery. As he mentally continued to descend the pyramid, he was simultaneously retrogressing in time, descending in the scale of culture, and spreading geographically; which is but another way of representing the same thing that I have been trying to picture in terms of space alone.

We can then accurately speak of the center and chief origin of our generic Southwestern Indian culture as being located among these four Pueblo groups. Even within the narrow Pueblo region it is practically certain that at some time in the past, perhaps a thousand years ago, the intensest focus or acme of the culture was in the San Juan drainage district, where there are no Pueblos at all now; and at some later time, but still before the discovery of America, this nourishing hearth had shifted eastward and become located among the Tewa on the upper Rio Grande, where its development was arrested by the arrival of the disturbing Spaniard.

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This difference cuts across the Southwest rather deeply and shows in minor ways that may be very significant. At Zuni it is the custom for women to sit flat on the ground but for men not to do so. Sometimes the man uses an empty box; ordinarily he has built around the walls of his room a little ledge that forms a low sort of bench. In general, he no more thinks of sitting cross-legged on the ground than we do. The Navaho or Apache sits right down on the ground and crosses his legs. The various tribes are perfectly conscious of these customs. Once when I sat Turk-fashion, my Zuni companion immediately said, "Ah, you are Apache-sitting." Now, trivial as this is, such a departure of habits might easily cause different methods of serving food, or create different types of implements or of etiquette. Even where such a minor peculiarity results in nothing further, it may often be deeply suggestive of much greater distinctions.

In the discussion of a recent address before the New York Academy of Sciences,* Dr. Pliny E. Goddard called attention to one of these greater distinctions. The Apache and Navaho fear the dead body as they would fear smallpox or any other contagious disease. A person that has no near kin is likely not to be buried. If a man dies in a house his people move off and abandon the vicinity. Even if he dies out of doors, his house is not lived in again. Among the Pueblos it is different. People die in their rooms and the building is not pulled down. The Pueblo's attitude toward his dead lacks entirely this element of horror that the ghost may come back and work an injury—he feels slightly or not at all certain powerful emotions to which so many other Indian tribes are intensely susceptible. Dr. Goddard suggested that somehow the ancestors of the Pueblos got rid of their dead and therefore were enabled to congregate in houses of stone. One obviously cannot build a town and then move half a mile away when the first inhabitant dies. My own interpretation would rather be the reverse of Dr. Goddard's. I should say

*By Dr. Clark Wissler, January 28, 1918, on "Cultural Problem" in the Southwest."

At the head of this there are fourteen sets of four or five priests each, or one out of every six men. These are ranked and grouped, with certain divisions of function. In addition there is a head priest or sort of pope, one of a college of six cardinals, as they might be called, plus a speaker or sun-priest, a woman assistant, a grand dance manager, and two bow-priests or executive officers. The remaining Zuni are divided into six groups; each of which has its own kiva or ceremonial chamber, practically also a club. Each of these clubs has its manager and keeper of costumes. All this is only part of the scheme of organization of the one communal society. Beyond this are thirteen fraternal societies, each usually containing several grades or orders, and each with its head, deputy, speaker, and medicine keeper.

Enough of such details. It is clear that on the side of religion alone the average Zuni can hardly escape holding some office or function during his life because his scheme of ritual organization is so elaborate as to provide almost as many offices as there are possible incumbents. Among the Plains Indians there is nothing like this. Such simple forms of organization as they possess are absolutely rudimentary in comparison.

What I am trying to show is that these culture phenomena must have a reaction on the individual's psychology. The Zuni does not think of an individual except as a part of a machine. Organization is so dominant in his life, so stamped all over himself and his associates, that personality is considerably stamped out of him; whereas the loosely organized Plains tribesman has every opportunity to foster his individuality and to be direct and frank in the expression of his character.

Just so, the Zuni always inclines to think of the symbolic meaning of an act rather than of the act itself. His whole mythology, the history of his people as he tells it, is more or less in this symbolic form. What is not symbolic, he has left out. If he is forced by circumstances or induced by advantage to take up new things, such as sheep or wool or woolen cloth, he says to himself: "We are indeed using them, but they are unsymbolic and not old and therefore we will not use them in religion." Then he gradually begins to use these things nevertheless, because it is convenient, but he still denies employing them. Anything that is used in any ceremonial connection must contain nothing of Caucasian origin, is the rule; but actually there are few ritual paraphernalia that do not include something which has been produced by the white man. The Zuni uses these paraphernalia but still tries to explain the fact away: again a psychological factor. After the innovation has been with him long enough, he finally manages to say to himself: "Of course we have always had this material. Our creation story tells how it came

*Dr. Robert H. Lowie, of the American Museum, in his field study of North American Indians, has gone from the Plains to the Pueblos, and has several times dilated on this very striking difference.

*In an address on the "Archaeology of the Southwest," delivered before the New York Academy of Sciences, February 25, 1918.

up out of the ground with us and was always Zuni." So he has at last made the Caucasian importation a real part of his mythological and symbolic form which he loves so much. Again, a tendency of his civilization has dictated his personal and group conduct.*

*As a study representative of tills more or less psychologic method of approach of culture. I might mention the famous historical novel "The Delight Makers" by Bandelier, the pioneer of Southwestern research. By no means of the highest rank as a piece of fiction, the book is nevertheless pervaded by a keener and more comprehensive insight into the psychic reactions accompanying the manifestations of Pueblo culture than any other work in the field. Of similar order, although formally much more scientific, is the essay by the late Dr. H. K. Haeberlin of the Museum, on the idea of fertilization among the Southwestern Adlana. This monograph is misunderstood if it is regarded as an attempt to reduce the entire civilization of the Southwest

I think these illustrations are perhaps enough to show that a mere interpretation according to the three sets of factors with which we began our consideration does not exhaust the field. The psychic aspects are also present. And they are in some measure utilizable in explanation as soon as we can bring them into definite relation with institutional phenomena. Most of what can be done along this line still belongs to the future; but it is important not to overlook the opportunities of the future.

The anthropologist works, then, not by denying the reality of the factors of heredity and environment but

to a single formula. It does endeavor, and on the whole with remarkable success, to view as much as possible of the culture in its relations to one of its dominant attitudes of mind.

by going beyond them. He does not seriously operate with them because in his own field he has been able to accomplish nothing with them. The progress which he has made and which justifies his reliance in his method and technique, has been achieved by painstaking analysis of human cultures into cultural elements; by tracing the connection, first in space, then in time, then in cause and effect, between culture element and culture element, between culture and culture; by explaining phenomena of civilization not in terms of the underlying organic constitution or surrounding nature, but in terms of civilizational phenomena themselves; with human mentality never left out, but always regarded only as it is acted on by custom and institution and reacts on them.

The Stokes Bomb-Throwing Gun—I*

And Its Development

By Sir Wilfred Stokes, K.E.B.

IT has been with great diffidence that I have undertaken to address you today as the third Gustave Canet Lecturer. The subject which your Council has approved of is one about which, three years ago, I knew practically nothing, nor can I today claim any deep knowledge which justifies me in standing before you and stating that I have solved any great problems hitherto obscure. My only possible justification is that I have been permitted to introduce into modern warfare a weapon of unusual simplicity and lightness which may possibly tend to exert an influence on the direction of checking the tendency to complication and intricacy which, I fear, is the vogue among modern expert designers.

The first Canet Lecture, which was delivered by Sir Trevor Dawson in 1909, dealt with "The Engineering of Ordnance," involving designs and methods of manufacture which are the outcome of long years of study and experience. The evolution of ordnance must of necessity depend to a large degree upon the process of trial and error, which naturally leads further and further from primitive simplicity. Cause and effect are not always obvious. Minds become set in one direction, and not inclined to retrace steps which have, perhaps under slightly different conditions, not been fruitful of good results.

I venture therefore to throw out the suggestion that

All this, you may think, has little or no bearing on the subject more particularly before us this evening. My retort, however, is that modern warfare has now developed into one of exhaustion of men and money.

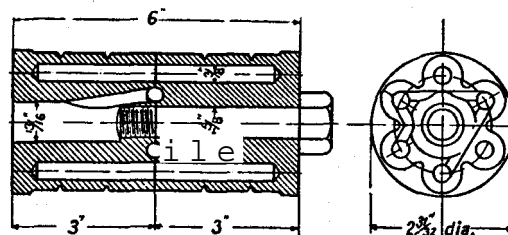
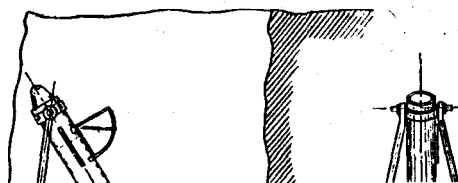


Fig. 1—Original compartment bomb

Simplicity in design means small cost and quick delivery, not to mention other advantages in the field. I would therefore ask you to pause, perhaps longer than you otherwise would feel inclined to do, in the



shortly, the proposal consisted of a cast-iron bomb with six compartments containing explosive, with a time-fuse which was lighted at the moment of firing, and which was so arranged that each of the six compartments exploded at unequal intervals. At each explosion it was intended that the bomb would be blown into a fresh position, and that, therefore, if it fell into a trench it would be very searching and demoralizing. A seventh compartment placed centrally contained a cartridge holding the propellant. The gun, or howitzer, for firing the bombs was a simple tubular barrel with two adjustable legs, thus forming a tripod. The recoil was taken by a cast-iron bowl attached to the base of the barrel.

The lower end of the barrel was provided with a pointed central rod for the purpose of firing the propellant cartridge, when the bomb was allowed to slide down to the bottom of the barrel. The main features of the scheme thus were: (1) A bomb producing successive explosions. (2) A bomb provided with its necessary charge of propellant ready for firing. (3) A simple gun without moving firing mechanism capable of automatically firing bombs as quickly as they could be fed into the muzzle and allowed to slide down to the spike at the bottom.

From this somewhat sketchy scheme there ultimately emerged the weapon and projectiles which it is my privilege to describe to you this evening, by going through the